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Procedia Engineering 73 (2014) 305 – 310

Procedia Engineering

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Geological Engineering Drilling Technology Conference (IGEDTC), New International Convention Exposition Center Chengdu Century City on 23rd-25th May 2014

Animation Design and Production of Kilometer Directional Drilling Technology and Equipment

Yao Ke[a], Shi Zhijun[a], Chen Guo[b], Fang Peng[a]*, Wu Di[a],

Sun Baoshan[a], Shao Junjie[a], Li Dong[a]

[a]*Xi'an Research Institute Co., Ltd of China Coal Technology & Engineering Group Corp, Xi'an 710077,China*
[b]*China University of Geosciences (Wuhan), Wuhan 430074, China;*

Abstract

Combined with the Measure While Drilling (MWD) system of the new kilometers directional drilling rig and the method of directional drilling technology, this paper uses animated video technology of product to simulate the major workflow and the actions of whole technology and equipment which used to construct drilling hole for gas drainage in the coal mine, and the production of the animated videos make the related personnel establish the full visual impression in the practical application course of whole directional drilling technology and equipment, and it also could be used for the propaganda of related technology products and personnel technical training, and help to promote the application of this technology.

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Selection and peer-review under responsibility of Geological Engineering Drilling Technology

Keywords: Directional Drilling Technology; Construction of Drilling Hole; Animation Design; Simulate

1. Introduction

It is understood that, there has been no complete and high level video description of the actual construction situation about the coal mine gas drainage and directional drilling. It can be said that this aspect of work is blank on the whole. Coal mine construction equipment also faces the same dilemma. The videos we only have are just some

* Corresponding author. Tel.: +8618991210218/+8629+81881654.
E-mail address: fangpeng@cctegxian.com

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Selection and peer-review under responsibility of Geological Engineering Drilling Technology
doi:10.1016/j.proeng.2014.06.203

parts of video clips, the performance practices of which are simple and unfocused, and the effect is always unsatisfactory. The main reason is that the video shooting of the special environment in coal mine is restricted by the objective conditions, such as safety explosion-proof, lighting and the floor space and so on, so that it could not be shot in conventional methods and techniques. Therefore, there are considerable difficulties to achieve the shooting as the same conditions on the ground.

With the extension of computer technology in the field of video and the development of the production software, three-dimensional digital imaging technology extends the limitations of film shooting, which makes up the lack of shooting in the visual effects, and the diversity of technical means and effects are no less than the shooting in camera directly. In addition, the cost of computer generated video than real shooting cost incurred much lower. From the simple geometry model to complex three-dimensional scene, such as roads, tunnels of linear engineering and landscape design of site works, three-dimensional animation could performance these scenes design vividly. Therefore, by the way of animated video, the simulation and performance of various kinds of practical scenarios have become a trend in the impact of technological development.

Relying on" hard-coal superpower directional drilling technology and equipment" of national "twelfth-five-year plan" special major science project, this paper uses animation software and tools; combines with the new directional drilling and MWD system and the method of directional drilling technology; simulates the main workflow and capabilities actions of complete technology and equipment in the coal mine gas drainage drilling and construction; shows using conditions and main features of the new directional drilling technology products in the actual drilling field; strives to use the way of animation so that the related personnel could establish the full visual impression in the practical application course of whole directional drilling technology and equipment.

2. Animation Designing Software

Today 3D Max and Maya are major 3D animation production software.3D Max is a very strong practicality and mainstream three-dimensional design software, which not only has a strong three-dimensional modeling, material making, lighting and scene editing functions, but also its abilities of the three-dimensional animation design, editing, making and generating are very strong. It has a wide range of applications in industrial design, architectural design, engineering visualization and other fields. When building transportation vertical wells, cages, coal roadways and other underground constructions, 3D Max has an absolute advantage in the using for architectural renderings and animation of the building. Thus, in the animated video production process of coal mine directional technology and equipment, selecting 3D Max as the basic production software, we could complete the design and production of all videos.

3. Animation Designing and Production

Completing three-dimensional animation creation needs experience modeling, texturing, animation, lighting, rendering and a series of steps and basic operation process, in particular the application of body shape, motion control and picture coloring these three important three-dimensional animation techniques [1]. In order to make the technical staff and the viewers have a complete and intuitive impression about the status of the entire equipment's field application, we hope to give people fresh visual effects and impressions through interesting script, refined styling, layered backgrounds, smooth motion, rich lighting effects and other high level animation elements [2].

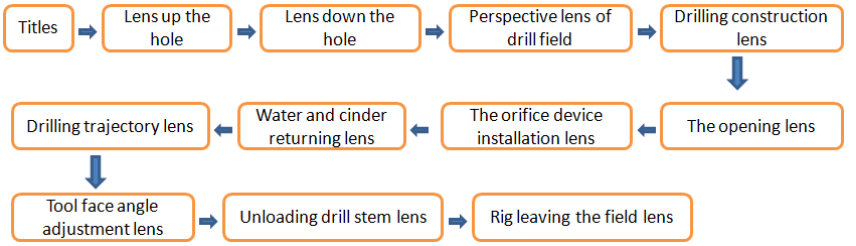

Fig. 1. Script Flow Chart of Animation.

Animation scripts planning selects the simulation of the complete process such as devices going down the well, transportation, drilling field arranging, fixtures, accessories installation, drilling operations and other important process and the key technology steps, which uses the full advantage of the three-dimensional animation software 3D Max. This software possesses the depth lens changing, lighting and background music and other technical means, so that the entire animated clips have rich and complete contents, beautiful and simple pictures and prominent images. We could find the storyboarding process in fig.1 that an animation design and driller and two loading and unloading auxiliary staffs, which are arranged in the appropriate working position. Even the water surface in the tank is also rendered in the state of fluctuation, and the picture of the entire drilling field would become more real and vivid.

3.1. Three-dimensional Modeling and Simplifying

Model design in the entire animation is particularly important, while model itself is not the finally finished video work, and complete animation needs the original animation design, front and back view syntheses, dubbing, editing and many other processes. Because modeling must be tested in each part and consider the requirements of every aspect during the entire animation working. Good modeling basis and design of analog stereo would help the movie achieve the desired effects.

Through analysis and module division of the three-dimensional model of directional drilling technology and equipment, and simplifying each model of each module, we retain the visible appearance parts and remove the internal invisible parts, so that the efficiency of the computer running the animation synthesis could be improved. Specific process is as follows:

(1)Three-dimensional model of directional drilling: According to the original the three-dimensional solid edge file of directional drilling and each assembly drawing and parts diagram of each part model, we remodel and deal with the details in 3D Max, requiring the size of the model in 3D Max in strict accordance with each dimension standard in the assembly drawings and parts diagrams of directional drilling. The three-dimensional model of the directional drilling is shown in fig.2.

(2)Three-dimensional model of pump for directional drilling: According to the original three-dimensional solid edge file of pump and assembly drawings and parts diagrams, we establish the corresponding three-dimensional model of pump matching the directional drilling in 3D Max, and require the models in 3D Max in strict accordance with each dimensions standard in the assembly drawings and parts diagrams of the pump. The three-dimensional model of the pump is shown in fig. 3.

(3)Three-dimensional model of cages, roadways, gas-water separators, tanks, orifice devices, characters, drilling poles, drill and so on: According to the certain representative specification of mine cages, the transporting conditions of roadways and the structure dimension of the actual on-site construction and accessory equipment, we could establish these models.

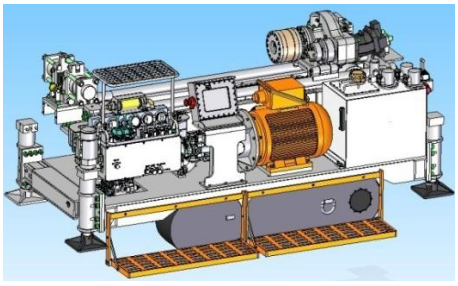

Fig.2 3D Model of Rig

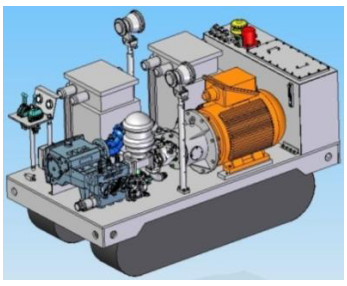

Fig.3 3D Model of Pump.

3.2. Three-dimensional Scene Modeling

The three-dimensional scene is divided into two parts, up and down the mine. We just establish a visual impression of the upper part of mine, which is a brief description of the scene and the approaches about how equipment decentralizing through the mine in the shaft cages. We only analog the scene of equipment going into the shaft cage to avoid the complex model and messy picture. The three-dimensional model of the upper part of the mine scene is shown in Fig.4. The underground part is mainly composed of both the flatbed rail transporting scene and the actual drilling site. After the devices have been shipped out from the rail flatbed, the devices would be directly transported to the nearest place from the drilling field, and then the devices will be operated to travel to the drilling field when it is powered on. The three-dimensional model of the underground part in the mine scene is shown in Fig.5. The drilling field scene is the film's focus, and it is for the performance of the layout about rigs and related equipment in the construction site and construction cases. The scene consists mainly of drilling rigs, drilling tools, orifice devices, gas drainage pipes, pumps, tanks, roadways, drilling and related staves.

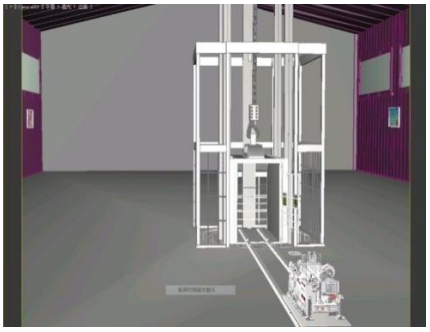

Fig.4 3D Model of Scene up the Hole

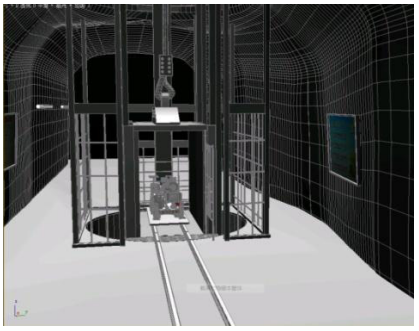

Fig.5 3D Model of Scene Down the Hole

3.3. Lighting Effects and Material Textures

After all objects models and scenes models are completed, based on the principles of achieving the real scene effects, we add the appropriate lighting in the scene. The directional drilling rig equipment consists of the rig and the mud pump. The mud pump provides high pressure water to driving the down-hole screw motor during directional drilling, while the pump also integrated installs explosion-proof electrical cabinet, gas-proof lock switch and two lights. The lights illuminate the empty field and connecting drill pipes behind the rig during the normal drilling. In animation design, we need adjust the corresponding parameters in the software to achieve the most realistic effect, which must base on the needs of lighting configuration in the real drilling site.

After adding the lighting effects in three-dimensional scenes, we need give each model corresponding material to try and remain close to the underground actual drilling site. In order to enhance the visual effects, we need appropriate adjustments on some model's textures and colors, and increase the contrast so that we could clearly distinct all objects in the drilling field with poor lighting conditions in the roadway, such as steel anchor rods, plates for steadying the whole rig and contact with the roadway floor, orifice integrated gas pipeline, etc.

3.4. Animation

Upon the completion of the preparatory work above, we could start the animation, and the specific process includes the following steps:

(1)Identifying relevant action links

Finishing all the basic models, we need determine the relationship between parent-and-son action, and link the related actions between each part model in the need of animation.

(2)Scripting

After all the related action links given to the models, we should determine all animation to express and lens animation needs.

(3)Animating

When finishing the script writing, animation production could begin. The each frame in model animation and camera animation must be set strictly as the written script during the production process. After finishing setting each key frame, we must continuously analog and adjust all key frames to check the key frames are reasonable or not, to avoid malfunctions.

The three-dimensional animation has not only the movement effect of up and down, or left and right, but also the prominent effect of front and back (depth), which could greatly enhance the stereo perception and the sense of space. The good combination between three-dimensional animation and two-dimensional animation appears advantages, such as 360°panning, etc., while it is difficult to be drawn out of two-dimensional[3]. For example, when the actual situation of the drilling field and supporting the overall equipment are shown comprehensively and intuitively, we would be absolutely clear on the situation of the drilling field and ancillary equipment through propelling the panoramic lens from far to near behind the far distance. Another example, when we want to perform the configurations of the orifice device and the working status, we may use the wide-angle pan from the top to sweep these things including pipes on the sidewalls of roadway, the pipes of orifice device, the falling cinder, water returning from the holes, the power head assembly in motion and the spinning drill stem, so that the whole movie is made on a very comprehensive and vivid performance.

3.5. Animation Outputting and Post-production

After completing all the animation and simulation to achieve the effect of each animation, the animation needs to be rendered for outputting. We select the mental ray renderer built-in the 3D Max for rendering output, and the outputting file format of renderings is *.tga and must be maintained to a specified folder. When all the animation rendering completed, we need poet-production work that all *.tga files will be inputted into the video processing software After Effects with animation titles for animation synthesis in accordance with the prior written storyboards, then according to the overall effect of the animation and scene needs, we could add suitable background music and appropriate animation effects in the video. We can choose the audio file format such as *.avi, *. flv, *.mov, *.wmv and so on. The complete outputting animation contains a set of all the action shots and background music, so the work of the entire production and animation outputting is completed. Through the finally finished animated screenshot of the directional drilling construction in fig.6, the directional drilling during construction and panoramic site can be clearly reflected in underground coal mine. Fig.7 shows the real directional drilling rig construction in detail, from which we could clearly find out the borehole trajectory of the construction, that there is a main hole and some branch holes constructed in the fixed field. By this way of the gas extraction drilling construction, we could effectively improve the efficiency of construction and the gas extraction rate.

Fig.6. Screenshot of the Directional Drilling Construction.

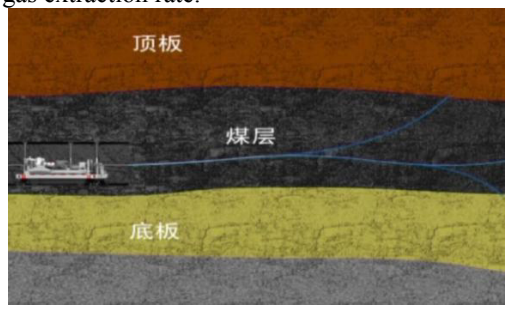

Fig.7. Directional Drilling Construction.

4. Conclusions

(1)Before the animation designing and making, the models of the rigs and the graphics must be simplified in order to facilitate the production of solid models.

(2)The design and production of rig's three-dimensional animation complete these processes, such as rig going into and out of cages, installation and removal drilling stem, drilling, opening, orifice devices installation, returning water and cinder, adjusting the tool face angle and, etc. The animation greatly reappear the actual working situation of rig and lays the foundation for the further improvement of rig designing.

(3)The integrated design in animation, lighting, material and sound achieves the effective integration of engineering technology and the visual arts, and also has a useful exploration about the visual design and motion simulation of the drilling equipment.

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